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विद्युत उपस्कर — घरेलू और समान संस्थापनों के लिए ओवरकरंट से सुरक्षा हेतु परिपथ वियोजक

भाग 2 प्रत्यावर्ती धारा और दिष्ट धारा के प्रचालन के लिए परिपथ वियोजक

Indian Standard

ELECTRICAL ACCESSORIES — CIRCUIT-BREAKERS FOR OVERCURRENT PROTECTION FOR HOUSEHOLD AND SIMILAR INSTALLATIONS

PART 2 CIRCUIT-BREAKERS FOR ac AND dc OPERATION

ICS 29.120.50

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

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NATIONAL FOREWORD

This Indian Standard (Part 2) which is identical with IEC 60898-2 : 2003 'Circuit-breakers for overcurrent protection for household and similar installations: Part 2 Circuit-breakers for a.c. and d.c. operation' issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Low-Voltage Switchgear and Controlgear Sectional Committee and approval of the Electrotechnical Division Council.

This standard is a part of the following series of standards which supersedes IS 8828 : 1996 'Electrical accessories — Circuit-breakers for overcurrent protection for household and similar installations':

IS/IEC 60898-1 : 2003 Electrical accessories — Circuit-breakers for overcurrent protection for household and similar installations: Part 1 Circuit-breakers for a.c. operation

IS/IEC 60898-2 : 2003 Electrical accessories — Circuit-breakers for overcurrent protection for household and similar installations: Part 2 Circuit-breakers for a.c. and d.c. operation

This standard is to be read in conjunction with IS/IEC 60898-1 : 2003 'Electrical accessories — Circuit-breakers for overcurrent protection for household and similar installations: Part 1 Circuit-breakers for a.c. operation'.

The text of IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain terminology and conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker, while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

Only the English text of the International Standard has been retained while adopting it as an Indian Standard, and as such the page numbers given here are not the same as in the IEC Publication.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be same as that of the specified value in this standard.

Indian Standard

ELECTRICAL ACCESSORIES — CIRCUIT-BREAKERS FOR OVERCURRENT PROTECTION FOR HOUSEHOLD AND SIMILAR INSTALLATIONS

PART 2 CIRCUIT-BREAKERS FOR ac AND dc OPERATION

1 Scope and object

This clause of Part 1 is applicable except as follows:

Addition at the end of the first paragraph:

This standard gives additional requirements for single- and two-pole circuit-breakers which, in addition to the above characteristics, are suitable for operation with direct current, and have a rated d.c. voltage not exceeding 220 V for single-pole and 440 V for two-pole circuit-breakers, a rated current not exceeding 125 A and a rated d.c. short-circuit capacity not exceeding 10 000 A.

NOTE This standard applies to circuit-breakers able to make and break both a.c. current and d.c. current.

Delete the last two paragraphs.

2 Normative references

This clause of Part 1 applies.

Delete IEC 61009-1:1991, IEC 61009-2-1:1991 and IEC 61009-2-2:1991.

3 Definitions

Clause 3 of Part 1 applies with the following modification:

Addition:

3.5.10.3
time constant
the rise time $T = L/R$ (ms) of a prospective direct current to reach a value of 0,63 times the maximum peak current

4 Classification

Clause 4 of Part 1 applies with the following modifications:

4.1 According to the number of poles

Replacement:

- single-pole circuit-breakers;
- two-pole circuit-breakers with two protected poles.

4.5 According to the instantaneous tripping current (see 3.5.17)

Delete D-Type.

Addition:

4.7 According to the time constant

- Circuit-breakers suitable for d.c. circuits with a time constant of $T \leq 4$ ms.
- Circuit-breakers suitable for d.c. circuits with a time constant of $T \leq 15$ ms.

NOTE It is assumed that short-circuit currents of 1 500 A are not exceeded in installations in which, due to the loads connected, time constants in normal service up to 15 ms can occur. Where higher short-circuit currents may occur, the time constant of $T = 4$ ms is considered sufficient.

5 Characteristics of circuit-breakers

Clause 5 applies with the following modification:

5.3.1 Preferred values of rated voltage

Replacement:

The preferred values of rated voltages are given in table 1.

Examples of connections of circuit-breakers in d.c. systems are given in figure 18.

Table 1 – Preferred values of rated voltage

Circuit-breakers	AC		DC [b]	
	AC circuit supplying the circuit-breaker	Rated voltage a.c.	Rated voltage d.c.	DC wiring examples
Single-pole	Single-phase (phase to neutral)	230 V	220 V	Figure 18a
	Single-phase (phase to earthed middle conductor, or phase to neutral)	120 V	125 V	
	Single-phase (phase to neutral) or three-phase (3 single-pole circuit-breakers) (3-wire or 4-wire)	230/400 V	220 V	
Two-pole	Single-phase (phase-to-phase)	400 V	220/440 V	Figures 18b, 18c, 1[illegible]
	Single phase (phase-to-phase, 3-wire)	120/240 V [a]	125/250 V [a]	

Applicable for d.c. voltages:

[a] Also for single-pole circuit-breakers to be used in pairs at 250 V d.c. (respectively 240 V a.c.) and individually at 125 V d.c. (respectively 120 V a.c.).

[b] The rated voltage per pole shall not exceed 220 V d.c.

Applicable for a.c. voltages:

NOTE 1 In IEC 60038 the network voltage value of 230/400 V has been standardized. This value should progressively supersede the values of 220/380 V and 240/415 V.

NOTE 2 Wherever in this standard there is a reference to 230 V or 400 V, it may be read as 220 V or 240 V, and 380 V or 415 V respectively.

NOTE 3 Circuit-breakers complying with the requirements of this standard may be used in IT systems.

The manufacturer shall declare in his literature the minimum voltage for which the circuit-breaker is designed.

Relevant tests are under consideration.

5.3.5 Standard ranges of instantaneous tripping

Replacement:

Table 2 – Ranges of instantaneous tripping

Type	Ranges for a.c.	Ranges for d.c.
B	Above 3 I_n up to and including 5 I_n	Above 4 I_n up to and including 7 I_n
C	Above 5 I_n up to and including 10 I_n	Above 7 I_n up to and including 15 I_n

6 Marking and other product information

Clause 6 of Part 1 applies with the following modifications:

Replacement:

c) rated a.c. voltage with the symbol ~ and rated d.c. voltage with the symbol ⎓

d) *replace* (B, C or D) *by* (B or C).

f) rated short-circuit capacity for a.c. and d.c. in amperes in one rectangle, without the symbol A, if valid for both a.c. and d.c. (see example 1 below). If the rated short-circuit capacity is different for a.c. and d.c. this shall be indicated in two adjacent rectangles, without the symbol A, with the symbol ~ near the rectangle containing the a.c. value and with the symbol ⎓ near the rectangle containing the d.c. value (see example 2 below).

Addition:

l) time constant *T*15 within a rectangle, if applicable, associated with the marking for the short-circuit capacity at the time constant of 15 ms (see example 3 below).

Replacement of the first paragraph following l):

If, for small devices, the space available does not allow all the above data to be marked, at least the information under c) and d) shall be marked and visible when the circuit-breaker is installed.

The information under a), b), e), f), g), h), i) and l) may be marked on the side or on the back of the device and be visible only before the device is installed.

Alternatively, the information under g) may be on the inside of any cover which has to be removed in order to connect the supply wires. Any remaining information not marked shall be given in the manufacturer's literature.

EXAMPLE 1 [6 000]

EXAMPLE 2 [10 000] ~

[6 000] ⎓

EXAMPLE 3 [1 500 | *T*15]

The terminals shall be marked with + or – if necessary. Additionally, arrows indicating the direction of the current are allowed.

7 Standard conditions for operation in service

Clause 7 of Part 1 applies.

8 Requirements for construction and operation

Clause 8 of Part 1 applies with the following modifications:

8.6.1 Standard time-current zone

Replacement:

Table 7 – Time-current operating characteristics

Test	Type	Test current a.c.	Test current d.c.	Initial condition	Limits of tripping or non-tripping time	Result to be obtained	Remarks
a	B, C	1,13 I_n		Cold*	$t \geq 1$ h ($I_n \leq 63$ A) $t \geq 2$ h ($I_n > 63$ A)	No tripping	
b	B, C	1,45 I_n		Immediately following test a	$t < 1$ h ($I_n \leq 63$ A) $t < 2$ h ($I_n > 63$ A)	Tripping	Current steadily increased within 5 s
c	B, C	2,55 I_n		Cold*	1 s < t < 60 s ($I_n \leq 32$ A) 1 s < t < 120 s ($I_n > 32$ A)	Tripping	
d	B C	3 I_n 5 I_n	4 I_n 7 I_n	Cold*	0,1 < t < 45 s ($I_n \leq 32$ A) 0,1 < t < 90 s ($I_n > 32$ A) 0,1 < t < 15 s ($I_n \leq 32$ A) 0,1 < t < 30 s ($I_n > 32$ A)	Tripping	Current established by closing an auxiliary switch
e	B C	5 I_n 10 I_n	7 I_n 15 I_n	Cold*	t < 0,1 s	Tripping	Current established by closing an auxiliary switch

* The term "cold" means without previous loading, at the reference calibration temperature.

8.8 Performance at short-circuit currents

Replacement of the third paragraph:

It is required that circuit-breakers be able to make and to break any value of current up to and including the value corresponding to the rated short-circuit capacity at rated frequency, at a power-frequency recovery voltage equal to 105 % (±5 %) of the rated operational voltage and at any power factor not less or any time constant not greater than the appropriate limit of the range stated in 9.12.5; it is also required that the corresponding values of I^2t lie below the I^2t characteristic (see 3.5.13).

9 Tests

Clause 9 of Part 1 applies with the following modifications:

9.1 Type tests and test sequences

Replacement of the first paragraph of 9.1.2:

The test sequences and the number of samples to be submitted are stated in annex C of this standard.

9.1.1

Replacement of the second paragraph after table 8:

The test sequences and the number of samples to be submitted are stated in annex C of this standard.

9.10.2 Test of instantaneous tripping and of correct opening of the contacts

Replacement:

9.10.2.2 For circuit-breakers of the B-type

An alternating current equal to 3 I_n is passed through all poles, starting from cold. The opening time shall be not less than 0,1 s and not more than:

- *45 s for rated currents up to and including 32 A;*
- *90 s for rated currents above 32 A.*

An alternating current equal to 5 I_n is then passed through all poles, starting from cold.

The circuit-breaker shall trip in a time less than 0,1 s.

A direct current equal to 4 I_n is passed through all poles, starting from cold.

The opening time shall be not less than 0,1 s and not more than:

- *45 s for rated currents up to and including 32 A;*
- *90 s for rated currents above 32 A.*

A direct current equal to 7 I_n is then passed through all poles, starting from cold.

The circuit-breaker shall trip in a time less than 0,1 s.

9.10.2.3 For circuit-breakers of the C-type

An alternating current equal to 5 I_n is passed through all poles, starting from cold.

The opening time shall be not less than 0,1 s and not more than:

- *15 s for rated currents up to and including 32 A;*
- *30 s for rated currents above 32 A.*

An alternating current equal to 10 I_n is then passed through all poles, starting from cold.

The circuit-breaker shall trip in a time less than 0,1 s.

A direct current equal to 7 I_n is passed through all poles, starting from cold.

The opening time shall be not less than 0,1 s and not more than:

- *15 s for rated currents up to and including 32 A;*
- *30 s for rated currents above 32 A.*

A direct current equal to 15 I_n is then passed through all poles, starting from cold.

The circuit-breaker shall trip in a time less than 0,1 s.

9.11 Test of mechanical and electrical endurance

9.11.1 General test conditions

Replacement of the fourth paragraph:

The alternating current shall have a substantially sine-wave form and the power factor shall be between 0,85 and 0,9.

The direct current shall have a ripple of $\omega \leq 5$ % and a time constant of T = 4 ms (with a tolerance of $^{0}_{-10}$ %) or, for circuit-breakers marked with T15, a time constant of T = 15 ms (with a tolerance of $^{0}_{-10}$ %).

9.11.2 Test procedure

Replacement of the first paragraph:

One set of circuit-breakers is submitted to 4 000 operating cycles at alternating current, and another set to 1 000 operating cycles at direct current, both at their rated current.

9.12.3 Tolerances and test quantities

Addition:

- *ripple* ≤ 5 %
- *time constant* $^{0}_{-10}$ %.

9.12.5 Power factor of the test circuits

Replacement:

9.12.5 Power factor and time constant of the test circuits

Addition:

For d.c. test currents up to and including 1 500 A, one of the following time constants shall be used:

T = L / R = 4 ms	*for devices not marked T15*
T = L / R = 15 ms	*for devices marked T15.*

For d.c. tests currents above 1 500 A and less than or equal to 10 000 A, the tests for all samples are made at the time constant of T = 4 ms.

NOTE It is assumed that short-circuit currents of 1 500 A are not exceeded in installations in which, due to the loads connected, time constants in normal service up to 15 ms can occur. Where higher short-circuit currents may occur, the time constant of T = 4 ms is considered sufficient.

9.12.8 Interpretation of records

Modification:

9.12.8.1 Interpretation of records in case of a.c. voltage

The existing text of 9.12.8 applies.

Addition:

9.12.8.3 Interpretation of records in case of d.c. voltage

a) Determination of the applied voltage and the recovery voltage.

The applied voltage and the recovery voltage are determined from the record taken during the break test.

The voltage on the supply side shall be measured after arc extinction and after high frequency phenomena have subsided.

b) Determination of the prospective short-circuit current.

NOTE The value of the prospective current is taken as being equal to the maximum value A_2 as determined from the calibration curve because circuit-breakers according to this standard break the current before it has reached its maximum value.

The maximum value of the prospective current is indicated as A_2 in figure 7b.

9.12.11.2 Tests at reduced short-circuit currents

Replacement:

9.12.11.1 Tests at reduced short-circuit currents and at small direct currents

Modification:

9.12.11.2.1 Tests at reduced a.c. short-circuit currents

The existing text of 9.12.11.1 applies.

Addition:

9.12.11.2.3 Tests at reduced d.c. short-circuit currents

direct currents the test circuit is adjusted so as to obtain a current of 500 A or $10 \times I_n$ whichever is the higher, at a time constant corresponding to the assigned time constant.

Each of the protected poles of the circuit-breaker is subjected separately to a test in a circuit, of which the connections are shown in figure 3.

The circuit-breaker is caused to open automatically three times, the circuit being closed once by the auxiliary switch A and twice by the circuit-breaker itself.

The sequence of operations shall be:

$$O - t - CO - t - CO$$

After arc extinction, the recovery voltage shall be maintained for a duration not less than 0,1 s.

9.12.11.2.4 Test at small direct currents up to and including 150 A

The circuit-breaker shall be closed three times on to each of the test currents listed below; during the tests the operating means is actuated as in normal use. If the circuit-breaker does not trip, it shall be switched off manually.

Test currents: 1 A, 2 A, 4 A, 8 A, 16 A, 32 A, 63 A, 150 A

The time between each operating cycle CO shall be at least 10 s, the closing time shall not be longer than 2 s. The time between the various test currents shall be at least 2 min.

The time of the arc extinction during the test shall not exceed 1 s.

9.12.11.3 Test at 1 500 A

Replacement of the first paragraph:

For circuit-breakers having rated short-circuit capacity of 1 500 A, the test circuit is calibrated according to 9.12.7.1 and 9.12.7.2, to obtain a current of 1 500 A at a power factor corresponding to this current according to table 17.

For direct current the time constant is calibrated corresponding to the assigned time constant.

Replacement of the second paragraph:

For circuit-breakers having rated short-circuit capacity exceeding 1 500 A, the test circuit is calibrated according to 9.12.7.1 and 9.12.7.3, at a power factor corresponding to 1 500 A, according to table 17.

For direct current the time constant is calibrated corresponding to the assigned time constant.

Replace the eleventh paragraph:

The sequence of operations shall be as specified in 9.12.11.2.1 and 9.12.11.2.3.

For single-pole circuit-breakers of rated voltage 230/400 V the operations for a.c. are as follows:

Subsequent to the six O operations only two CO operations are performed. In addition, these circuit-breakers are then tested by performing simultaneously one O operation, with one circuit-breaker being inserted in each phase of the test circuit for three-pole circuit-breakers (see figure 5). For this test the auxiliary switch establishing the short-circuit is not synchronized.

For the tests at d.c.

- *single-pole circuit-breakers of rated voltage 220 V are tested in a circuit according to figure 3;*
- *two-pole circuit-breakers of rated voltage 440 V are tested in a circuit according to figure 4b.*

9.12.11.4.2 Test at service short-circuit capacity (I_{cs})

Replacement of the first paragraph of a):

a) *The test circuit is calibrated according to 9.12.7.1 and 9.12.7.3, on a.c. with a power factor according to table 17, or on d.c. with a time constant according to 9.12.5.*

Addition:

e) *In the case of direct current, the test sequence for single- and two-pole circuit-breakers is:*

$$O - t - CO - t - CO$$

Three operations are made, the circuit being closed once by the auxiliary switch A and twice by the circuit-breaker.

Single-pole circuit-breakers of rated voltage 220 V are tested in a circuit according to figure 3.

Two-pole circuit-breakers of rated voltage 440 V are tested in a circuit according to figure 4b.

2.11.4.3 Test at rated short-circuit capacity (I_{cn})

Replacement of the first paragraph:

a) *The test circuit is calibrated according to 9.12.7.1 and 9.12.7.2, on a.c. with a power factor according to table 17, on d.c. with a time constant according to 9.12.5.*

Addition:

c) *In the case of direct current, the test sequence for single- and two-pole circuit-breakers is:*

$$O - t - CO$$

Two operations are made, the circuit being closed once by the auxiliary switch A and once by the circuit-breaker.

Single-pole circuit-breakers of rated voltage 220 V are tested in a circuit according to figure 3.

Two-pole circuit-breakers of rated voltage 440 V are tested in a circuit according to figure 4b.

9.12.12 Verification of the circuit-breaker after short-circuit tests

Addition at the end of 9.12.12.2:

The test of 9.12.11.2.4 is repeated but the test currents 63 A and 150 A are omitted.

Figures

The figures of Part 1 apply with the following modifications:

Renumber figure 7 as figure 7a.

Addition:

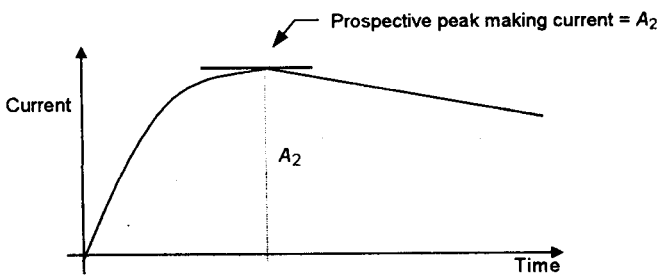
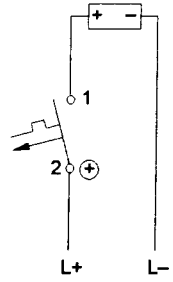
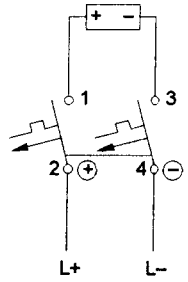
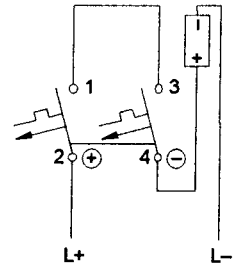
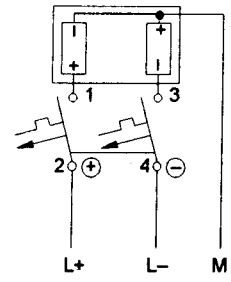


Figure 7b – Calibration of the test circuit in case of direct currents

Addition:

	a			b			c			d		
Circuit-breaker rated voltage	220 V	125 V	125/250 V	220/440 V	250 V	125/250 V	220/440 V	250 V	125/250 V	220/440 V	250 V	125/250 V
Maximum voltage between the conductors	220 V	125 V	125 V	440 V	250 V	250 V⎓	440 V	250 V	250 V	440 V	250 V	250 V
Maximum voltage between conductor and earth	220 V	125 V	125 V	220 V	125 V	125 V	440 V [a]	250 V [a]	250 V [a]	220 V	125 V	125 V
Circuit breaker	Single-pole			Two-pole			Two-pole			Two-pole		
Circuit												

[a] For applications with an earthed negative pole, where the voltage to earth is higher than the rated voltage of a single-pole circuit-breaker.

Figure 18 – Examples of connections of the circuit-breakers in different d.c. systems

Annexes

The annexes of Part 1 are applicable, except as follows:

Annex C

Annex C of Part 1 applies with the following modifications:

Replacement:

Table C.1 – Test sequences

Test sequence		Clause or subclause	Test performed at		Test (or inspection)
A		6			Marking
		8.1.1			General
		8.1.2			Mechanism
		9.3			Indelibility of marking
		8.1.3			Clearances and creepage distances (external parts only)
		8.1.6			Non-interchangeability
		9.4			Reliability of screws, current-carrying parts and connections
		9.5			Reliability of screw-type terminals for external copper conductors
		9.6			Protection against electric shock
		8.1.3			Clearances and creepage distances (internal parts only)
		9.14			Resistance to heat
		9.15			Resistance to abnormal heat and to fire
		9.16			Resistance to rusting
B		9.7			Dielectric properties and isolating capability
		9.8			Temperature rise and power loss
		9.9			28-day test
C	C_1	9.11	a.c.		Mechanical and electrical endurance
		9.12.11.2.1			Test at reduced a.c. short-circuit currents
		9.12.12			Verification of circuit-breaker after short-circuit tests
		9.11		d.c.	Mechanical and electrical endurance
		9.12.11.2.3			Test at reduced d.c. short-circuit currents
		9.12.11.2.4			Test at small direct currents up to and including 150 A
		9.12.12			Verification of circuit-breaker after short-circuit tests
	C_2	9.12.11.2.2	a.c.		Short-circuit test for verifying the suitability of circuit-breakers for use in IT systems
		9.12.12			Verification of circuit-breaker after short-circuit tests
D	D_0	9.10	a.c.	d.c.	Tripping characteristic
	D_1	9.13	a.c.	d.c.	Mechanical stresses
		9.12.11.3			Short-circuit performance at 1 500 A
		9.12.12			Verification of circuit-breaker after short-circuit tests
E	E_1	9.12.11.4.2	a.c.	d.c.	Service short-circuit capacity (I_{cs})
		9.12.12			Verification of circuit-breaker after short-circuit tests
	E_2	9.12.11.4.3	a.c.	d.c.	Performance at rated short-circuit capacity (I_{cn})
		9.12.12			Verification of circuit-breaker after short-circuit tests

NOTE With the agreement of the manufacturer the same samples may be used for more than one sequence.

Replacement:

Table C.2 – Number of samples for full test procedure

Test sequence		Number of samples		Minimum number of samples which shall pass the tests [a, b]		Number of samples for repeated tests [c]	
		AC ~	DC —	AC ~	DC —	AC ~	DC —
A		1		1			
B		3		2		3	
C	C_1	3	3	2 [e]	2 [e]	3	3
	C_2	3	3	2 [e]	2 [e]	3	3
D		3	3	2 [e]	2 [e]	3	3
E_1		3 + 3 [d]	3	2 [e] + 2 [d, e]	2 [e]	3 + 3 [d]	3
E_2		3 + 4 [d]	3	2 [e] + 3 [d, e]	2 [e]	3 + 4 [d]	3

[a] In total, a maximum of two test sequences may be repeated.

[b] It is assumed that a sample which has not passed a test has not met the requirements due to workmanship or assembly defects which are not representative of the design.

[c] In the case of repeated tests, all results shall be acceptable.

[d] Supplementary samples in the case of single-pole circuit-breakers of rated voltage 230/400 V.

[e] All samples shall meet the test requirements of 9.12.10, 9.12.11.2, 9.12.11.3 and 9.12.11.4 as appropriate.

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